Laparoscopy for small bowel obstruction: the reason for conversion matters

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Abstract: BACKGROUND: Although laparoscopy is associated with reduced hospital stay, early recovery, and decreased morbidity compared with open surgery, it is not well established for the treatment of small bowel obstruction (SBO). METHODS: This study analyzed a prospective nationwide database of the Swiss Association of Laparoscopic and Thoracoscopic Surgery. RESULTS: From 1995 to 2006, 537 patients underwent laparoscopy for SBO. Matted adhesions were the main cause of obstruction (62.6%). Intraoperative complications occurred for 9.5% of the patients. Postoperative morbidity was 14% and mortality 0.6%. Within 30 days, 13 patients (2.4%) were readmitted because of early recurrence or complications. The conversion rate was 32.4%. The conversions resulted from inability to visualize the site of obstruction or matted adhesions (53.4%), intraoperative complications (21.3%), and small target incisions for resection (25.3%). Emergency operations were associated with higher conversion rates (43.6% vs 19.8%; $p < 0.001$) but not with significantly more postoperative complications (15.2% vs 11.9%; $p = 0.17$). Intraoperative complications and conversion were associated with significantly increased postoperative morbidity (39.2% vs 11.3%; $p < 0.001$ and 24.7% vs 8.3%; $p < 0.001$, respectively). Reactive conversion due to intraoperative complications was associated with the highest postoperative complication rate (48.6%). Morbidity for preemptive conversion due to impaired visualization/matted adhesions or a small-target incision was significantly lower (20% and 26.1%; $p = 0.02$ and $p < 0.001$, respectively). American Society of Anesthesiology (ASA) scores higher than 2 also were associated with postoperative morbidity ($p < 0.001$). However, multivariate regression analysis showed that reactive conversion was the only independent risk factor for postoperative morbidity ($p < 0.001$; odds ratio, 3.97; 95% confidence interval, 1.83-8.64). CONCLUSIONS: Laparoscopic management of SBO is feasible with acceptable morbidity and low mortality but with a considerable conversion rate. Early conversion is recommended to reduce postoperative morbidity.

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Conclusions Laparoscopic management of SBO is feasible with acceptable morbidity and low mortality but with a considerable conversion rate. Early conversion is recommended to reduce postoperative morbidity.

Keywords Laparoscopy · Small bowel obstruction

Small bowel obstruction (SBO) after open abdominal surgery may occur for 3% of patients [1]. Surgery is mandatory when conservative management has failed. Although laparoscopy is associated with early recovery, reduced hospital stay, and decreased morbidity compared with open surgery [2], the minimally invasive approach is not yet established for the treatment of SBO. Surgeons still are reluctant to use laparoscopy due to distension of the small bowel, impaired working space, and the risk of iatrogenic small bowel injuries.

Several studies have shown the feasibility of laparoscopy for SBO, demonstrating its acceptable morbidity and low recurrence rates. However, most of the series were small or retrospective [3, 4], thus hampering the interpretation of the published results.

Laparoscopic surgery is not feasible for all patients with SBO. Conversion rates ranging from 7% to 43% have been published [4]. Conversion has notable clinical implications

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because it may lead to significantly increased postoperative morbidity rates [5, 6] compared with the rates for patients who could undergo laparoscopic treatment. The morbidity rates after conversion [5, 6] were even higher than those published for open surgery [7]. However, the lack of distinction between preemptive conversion due to impaired working space or dense adhesions and reactive conversion because of intraoperative complications further impedes evaluation of laparoscopy's safety for SBO.

The current study aimed to assess the role of laparoscopy for the treatment of SBO during the past decade. To this end, all the patients with SBO undergoing laparoscopy from 1995 to 2006 who were prospectively recorded in the database of the Swiss Association of Laparoscopic and Thoracoscopic Surgery (SALTS) were analyzed.

Materials and methods

The SALTS database

Since 1989, SALTS has prospectively collected data from patients undergoing various laparoscopic interventions at 114 surgical institutions (university, county and district hospitals, and private practices). The records of this prospective database represent more than 65% of all laparoscopic interventions in general surgery performed in Switzerland.

More than 130 parameters are recorded per patient including patient and treatment characteristics as well as data on postoperative complications. The data are recorded on standardized forms by the responsible surgeon and then transferred into the electronic database (Qualicare; Qualidoc Ltd., Liebefeld-Bern, Switzerland) by a data manager qualified to verify the completeness and accuracy of the data by identification of apparent mistakes (e.g., conflicting data). The database contains 72,350 documented laparoscopic procedures performed in Switzerland between 1995 and 2006.

Data collection

Data for 537 patients who underwent laparoscopy for SBO between 1995 and 2006 were identified in the database. Special emphasis was laid on intraoperative complications and conversion rates, as well as on postoperative morbidity and mortality. Outcome was assessed as in-hospital morbidity and mortality. Emergency procedures were defined as surgery performed within 24 h after hospital admission. The decision for a laparoscopic approach and the type of access (Veress needle or open Hasson approach) was made on an individual basis by the operating surgeons.

Conversion was divided into preemptive, laparoscopically assisted, and reactive types. We defined *preemptive* conversion as early conversion due to impaired visualization or dense adhesions. A small-target incision for resection was called a *laparoscopically assisted* conversion. Forced conversion due to intraoperative complications (bowel perforation, bleeding) constituted a *reactive conversion*.

Statistical analyses

Chi-square test, Student's *t*-test, and the Mann-Whitney *U* test were used where appropriate. Results are expressed as mean values ± standard deviation or as median (range). A p value less than 0.05 was considered significant. The standard program of the Statistical Package for the Social Sciences (SPSS, version 16.0, Chicago, IL, USA) was used for all the statistical analyses.

Results

Patient demographics

Between 1995 and 2006, 537 patients underwent laparoscopy for SBO. Of these 537 patients, 298 were women (55.5%) and 239 were men (44.5%). Their mean age was 58.2 ± 8.5 years, and their median body mass index (BMI) was 23.9 kg/m^2 (range, 14.2–42.6 kg/m^2). In terms of American Society of Anesthesiologists (ASA) classification, 206 patients (38.4%) were grade 1, 209 (38.9%) were grade 2, 106 (19.7%) were grade 3, 15 (2.8%) were grade 4, and 1 (0.2%) was grade 5. Emergency operations constituted 62.4% of the procedures ($n = 335$). The median time from hospitalization to surgery was 1 day (range, 0–74 days).

Laparoscopy for SBO over time

The laparoscopies for SBO ($n = 537$) reflect 0.7% of all the operations in the SALTS database performed during the same period ($n = 72{,}350$). This corresponds to 2% of all laparoscopic abdominal procedures, excluding cholecystectomies and appendectomies ($n = 27{,}317$). The number of laparoscopic procedures for SBO declined over time, with the average annual number of operations decreasing from 52.1 for 1995–2001 to 34.4 for 2002–2006 ($p < 0.001$) (Fig. 1).

Intraoperative data

For 62.6% of the patients ($n = 336$), matted adhesions were found, whereas banded adhesions were reported for 50.7%

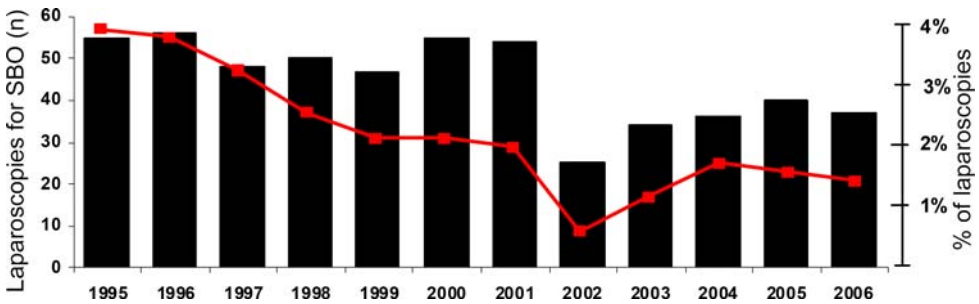

Fig. 1 Numbers of laparoscopic procedures for small bowel obstruction (SBO) (*black bars*), with their proportion in relation to all laparoscopic abdominal procedures (excluding cholecystectomies and appendectomies) performed in Switzerland during the study period (*gray line*)

($n = 272$). For 13.2% of the patients ($n = 71$), both matted and banded adhesions were described. Other reasons of SBO were small bowel volvulus (3.7%, $n = 20$), incarcerated hernias (2.8%, $n = 15$), invagination (1.1%, $n = 6$), and tumor obstruction (2.6%, $n = 14$). Experienced surgeons who had performed more than 100 laparoscopic procedures performed 83.2% ($n = 447$) of the operations.

The overall conversion rate was 32.4% ($n = 174$). Among these conversions, 53.4% ($n = 93$) were preemptive (because of inability to visualize the site of obstruction or due to matted adhesions), 21.3% ($n = 37$) were reactive (due to intraoperative complications), and 25.3% ($n = 44$) were laparoscopically assisted (due to a small-target incision for resection).

Intraoperative complications occurred for 9.5% ($n = 51$) of the patients. Of these complications, 37.3% ($n = 19$) could be managed laparoscopically, but for 62.7% ($n = 32$), conversion was required. Intraoperative small bowel injury during preparation occurred for 4.7% ($n = 25$) of the patients. For seven patients (1.3%), small bowel perforation was missed intraoperatively and detected only in the postoperative course. Injury due to insertion of a Veress needle or trocar was documented for 2% ($n = 11$) of the patients. The operation time was less than 90 min for 68.9% ($n = 370$) of the operations. This proportion was 52.9% (92/174) for converted cases compared with 76.6% (278/363) for nonconverted cases ($p < 0.001$).

Emergency operations were associated with significantly increased conversion rates (43.6% vs 19.8%; $p < 0.001$). Matted adhesions ($p < 0.001$) and an ASA greater than 2 ($p = 0.003$) also had a significant impact on conversion rates. A significant correlation with reactive conversion was found for matted adhesions ($p = 0.03$) and female gender ($p = 0.04$). Both parameters remained as independent risk factors in the multivariate analysis ($p = 0.02$; odds ratio [OR], 2.54; 95% confidence interval [CI], 1.14–5.63 and $p = 0.04$; OR, 2.47; 95% CI, 1.06–5.72, respectively).

Postoperative data

The overall morbidity and mortality rates were 14% ($n = 75$) and 0.6% ($n = 3$), respectively. Early recurrence or complications led to the readmittance of 13 patients (2.4%) within 30 days. Recurrence of mechanical SBO occurred for 1.9% ($n = 10$) of the patients, and 0.7% ($n = 4$) had to undergo surgery again. Intraoperative complications and conversion were associated with significantly increased postoperative morbidity (39.2% vs 11.3%; $p < 0.001$ and 24.7% vs 8.3%; $p < 0.001$, respectively). Reactive conversion due to intraoperative complications resulted in a higher postoperative complication rate (48.6%) than that for nonconverted cases (8.3%; $p < 0.001$). The morbidity rates associated with preemptive conversion (20%) and laparoscopically assisted conversion (26.1%) were significantly lower than for reactive conversion ($p = 0.02$ and $p < 0.001$, respectively).

Furthermore, ASA scores greater than 2 were highly associated with postoperative morbidity ($p < 0.001$). The morbidity rate was 11.1% for patients classified as ASA 1 or 2, whereas for patient with an ASA greater than 2, the morbidity rate increased to 23.8% ($p < 0.001$). In the multivariate regression analysis, reactive conversion was the only independent risk factor for postoperative morbidity ($p < 0.001$; OR, 3.97; 95% CI, 1.83–8.64).

Interestingly, the more experienced surgeons who had performed more than 100 laparoscopies did not have better rates than the surgeons with less experience for overall conversion (37.8% vs 34.5%; $p = 0.54$), reactive conversion (14.7% vs 19.7%, $p = 0.63$), or postoperative morbidity (13.3% vs 14.1%; $p = 0.99$). There also were no significant differences in morbidity rates between emergency and elective operations (15.2% vs 11.9%; $p = 0.17$). Increased BMI had a significant negative impact on reactive conversion due to increased intraoperative complications ($p = 0.04$), but BMI had no impact on the overall conversion rate ($p = 0.96$). Delayed postoperative bowel function was observed equally in converted (2.2%) and nonconverted (1.4%) patients ($p = 0.38$).

The median hospital stay after surgery was 5 days (range, 0–76 days) for elective operations and 7 days (range, 1–79 days) for emergency operations ($p < 0.001$). For converted cases, the median hospital stay was prolonged to 10 days (range, 2–76 days) compared with 4 days (range, 1–51 days) for nonconverted cases ($p < 0.001$). Laparoscopically assisted conversion resulted

in a hospital stay of 8 days (range, 2–34 days). Preemptive conversion required a hospital stay of 10 days (range, 3–76 days), and reactive conversion resulted in a hospital stay of 13 days (range, 6–59 days) ($p < 0.001$). The hospital stay was significantly longer after reactive conversion than after preemptive conversion ($p = 0.006$) or laparoscopically assisted conversion ($p < 0.001$) (Table 1).

Discussion

Intraabdominal adhesion formation remains a common problem after abdominal surgery, leading to substantial morbidity. This study reports the largest multicenter experience in laparoscopic surgery for SBO, based on a nationwide prospective database. We demonstrated that laparoscopy for SBO is feasible, with acceptable morbidity. However, the conversion rates were considerable. Notably, reactive conversions forced by intraabdominal complications almost doubled the morbidity rate compared with early preemptive conversion.

Traditionally, laparotomy has been considered the standard approach for the surgical management of SBO. But increasing evidence from recent studies shows that laparoscopy may be safe for the division of intraabdominal adhesions. The known benefits of laparoscopy, namely, reduced postoperative pain, reduced hospital stay, reduced scar formation [8, 9], and significantly reduced incidence of SBO after surgery [10] has led to increasing interest in the laparoscopic approach among patients with SBO. However, surgeons still are reluctant to use the laparoscopic approach in the setting of SBO because of the reduced working space and the risk of iatrogenic lesions, both due to bowel distention. Conversion rates are substantial, ranging from 15% to 52% [5, 6, 11–13], and morbidity rates are 0% to 47% [5, 6, 13–16]. However, most of these results are based on

Table 1 Patient demographics and summary of the perioperative data

	Lap ($n = 363$)	Preemptive[a] ($n = 93$)	Conversions ($n = 537$)	
			Lap-assisted[b] ($n = 44$)	Reactive[c] ($n = 37$)
Age (years)	50.4 ± 9.4	56.8 ± 9.0	56.2 ± 10.4	59.7 ± 7.6
Female (%)	52.3	58.1	61.4	73.0
ASA > 2 (%)	19.0	35.5	22.7	27.0
BMI: kg/m^2 (range)	23.9 (14.3–42.6)	23.9 (14.2–37.7)	24.1 (18.0–37.7)	21.7 (14.4–30.8)
Matted adhesions (%)	47.2	55.9	27.3	64.9
Banded adhesions (%)	53.2	51.6	34.1	43.2
Intraoperative complications (%)	3.0	2.2	2.3	100
Organ injury (Veress/trocar)	0.8	0.0	0.0	21.6
Organ injury (at preparation)	1.9	0.0	0.0	48.6
Bleeding (abdominal wall)	0.3	0.0	0.0	0.0
Bleeding (intraperitoneal)	0.0	0.0	2.3	10.9
Others	0.0	2.2	0	18.9
Postoperative morbidity (%)	8.5	19.4	20.5	45.9
Wound infection	1.4	4.3	4.5	21.6
Bleeding	0.3	1.1	0.0	0.0
Perforation	1.4	0.0	0.0	5.4
Small bowel paralysis	1.6	1.1	0.0	5.4
Small bowel obstruction	1.1	3.2	2.3	5.4
Lung embolism	0.0	2.2	0.0	0.0
Pneumonia	1.4	4.3	4.5	0.0
Cardiac	0.8	3.2	6.9	2.7
Others	0.5	0.0	2.3	5.4
Postoperative mortality (%)	0.0	2.2	2.3	0.0
Hospital stay (days)	4 (1–51)	10 (3–76)	8 (2–34)	13 (6–59)

Lap laparoscopy; *ASA* American Society of Anesthesiology, *BMI* body mass index

[a] Conversion because of inability to visualize the site of obstruction or due to matted adhesions

[b] Conversion due to intraoperative complications

[c] Small-target incision for resection

small retrospective, single-center studies, hampering a comprehensive evaluation of the data.

In the current multicenter study based on a large prospective database, the conversion rate was 32%, and the postoperative morbidity rate was 14%. For 21% of the converted patients, conversion was reactive (due to intraoperative complications). These figures correspond well with the results of a recently published review analyzing the data of 19 publications including more than 1,000 patients. This review reported a conversion rate of 33%, with one-third of those conversions being reactive [4].

The selection of patients seems crucial to avoiding conversion, especially reactive conversion, and hence, postoperative morbidity. Stringent selection criteria to identify good candidates for laparoscopy would be desirable, but such predictive parameters still are lacking. The risk factors for conversion and reactive conversion identified in our study are important but will not really facilitate preoperative decision making. In another study, small bowel diameter exceeding 4 cm was identified as a preoperative risk factor for conversion [5]. However, no differentiation of conversion (preemptive vs reactive) was made. Because data on bowel diameter were not recorded in our database, we are unable to confirm this finding. In the absence of clear preoperative selection criteria for a laparoscopic approach, a low threshold for early conversion seems to be critical because reactive conversion is associated with a substantial increase in morbidity.

Different conversion rates may partly explain the diverging figures on morbidity in the surgical literature because conversion has been repeatedly identified as a risk factor for postoperative morbidity [5, 6, 11, 14, 16–18]. Consistent with these reports, conversion was significantly associated with increased morbidity in our study. However, the impact of conversion on postoperative morbidity probably is seriously underestimated because preemptive, laparoscopically assisted and reactive conversions rarely have been distinguished. In our study, postoperative morbidity was significantly greater after reactive conversion than after preemptive or laparoscopically assisted conversions.

Although laparoscopic surgery in the emergency setting is widely applied (e.g., for appendicitis), laparoscopic treatment of SBO still is not fully adopted because of safety concerns. Indeed, laparoscopy can lead to higher rates of bowel perforation than conventional surgery [5, 11]. In the review by Ghosheh and Salameh [4], the rate of small bowel perforation in laparoscopic surgery for SBO was 6.5%. The rate of 4.7% in our study was comparable. However, only 1.3% of the perforations were missed intraoperatively. In the study of Suter et al. [5], accidental bowel perforation and the need for conversion were the only independent risk factors for postoperative complications. We obtained similar data, with intraoperative complications and conversion being risk factors for postoperative morbidity in the univariate analysis. However, only reactive conversion was an independent risk factor for postoperative morbidity in our patient cohort.

Laparoscopically treated patients had a significantly shorter hospital stay than patients who underwent conversion, as reported also in other studies [2, 6, 19], leading to lower total hospital costs [2]. In our study, the difference in the length of hospital stay between converted and nonconverted cases was 6 days. This time increased to 9 days when reactively converted and nonconverted cases were compared. A faster recovery of bowel function was reported to be an additional advantage of laparoscopy for acute SBO compared with converted cases [6]. In the study of Wullstein and Gross [11], laparoscopy was further followed by a shorter duration of postoperative bowel paralysis, even when conversions were included. However, we did not observe such a difference in our study. Furthermore, in contrast to a previous finding [6], the time point of surgery (within 24 h after admission vs 24 h after admission) did not have an impact on the conversion rate in our patient cohort. Additionally, neither the ASA score nor BMI influenced the need for conversion, which is in contrast to the findings of another study [2].

Interestingly, we observed a decreased use of laparoscopy for SBO in Switzerland in recent years. This may reflect an increasingly reluctant attitude of the Swiss surgeons toward the laparoscopic approach for this indication. The considerable conversion and morbidity rates, particularly after conversion forced by intraoperative complications, may be an explanation for this somewhat unexpected finding.

Some considerations must be recognized when the results of our study are interpreted. First, most of the procedures were performed by experienced laparoscopic surgeons. Therefore, the general applicability of the study's conclusions may be open to discussion. Notably, however, no influence of the surgeon's experience on conversion and morbidity rates could be identified. Second, no data on the number of previous abdominal operations were collected in the database. However, the impact that the number of previous surgeries has on conversion rates is controversial [2, 15]. Third, this study reports on only short-term outcomes after laparoscopy for SBO. However, the study focused on evaluation of the patients' safety rather than on long-term success.

In conclusion, we provide strong evidence that laparoscopic management of SBO is feasible for more than two-thirds of patients, with acceptable morbidity and low mortality. A low threshold for conversion may further decrease postoperative morbidity significantly, rendering laparoscopy a valuable approach to SBO for selected patients.

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